

class of tool used for boring, &c. The stresses in the studs at the bottom of the thread are from 4000 lb. per square inch for small studs to 7000 lb. per square inch for large studs. The diameter of the studs is governed by the consideration that in the case of high-pressure cylinders the pitch should not be more than 3 to 3½ times the diameter of the studs. In the case of low-pressure cylinders the pitch may be as much as 7 to 8 times the diameter. Great care must be taken to provide bosses where necessary in ports and passages, to prevent the stud holes being drilled through into a steam space. This point sometimes is overlooked. The flanges and covers near the joint may have a thickness equal to the diameter of the studs plus J in. in the case of small studs, and diameter plus 1 in. for larger studs. All the studs should have the same diameter and the covers the same thickness for all cylinders.

The top covers are cast to suit the form of the pistons and are well ribbed for strength, the number of the ribs varying with the diameter of the cover and the steam pressure. The thickness of the cylinder covers and the ribs may be 0·7 to 0·8 of the thickness of the cylinder walls. A recess is formed in the cover for the piston-rod nut, and a circular rim or projection is often provided, which extends as high as the top of the recess, to accommodate the lagging plates for the cover.

When designing a cylinder, provision for the attachment of the lagging should not be forgotten, although the flanges themselves are usually sufficient for the purpose.

The area of cross section of the ports should be based upon the speed of the exhaust steam, which should not exceed if possible 100 ft. per second for high-pressure cylinders and 120 ft. per second for low-pressure cylinders. In the case of the latter, especially in large engines where piston speeds are high, it is often necessary to increase the speed of the steam, but then sometimes two piston valves are used, the spindles being connected to a common crosshead in the crank-case driven by one eccentric.

The distance pieces should be carefully designed, as they are subjected to heavy shock when water gets into the cylinders. The

stresses should be kept low, not higher than 800 to 1000 lb. per square inch. The top of the distance piece forming the bottom cylinder cover is usually coned to suit the piston, and is therefore of an inherently strong form. In the case of the high-pressure cylinder it is sometimes flat to suit the shape of the piston, but the presence of the stuffing box makes it possible to provide deep ribs in all cylinders. The studs which attach the distance piece to the crank-case can be less in number than those used for the cylinder, as there is no joint to be kept tight, but they will, of course, have a proportionately greater diameter. The bottom distance-piece flange should therefore be made thicker than the cylinder covers, to allow for the greater distance bridged by the studs. The distance piece is usually registered into the circular hole in the top of the crank-case, but some makers prefer to use dowel pins instead, thus giving means of adjustment which may be useful when erecting the engine in the shops.